ON SOME LITTLE-KNOWN BONES OF THE MAMMALIAN SKULL.

By R. Broom, M.D.

(Read June 27, 1906.)

The structure of the mammalian skull is usually assumed to be pretty thoroughly known, and in most text-books descriptions or diagrams are given of the various bones. Flower's well-known diagram has been repeated with or without slight modifications in a number of books, and many students have doubtless come to regard the mammalian skull as a very simple structure compared with the skull of the reptile. It may perhaps be in part owing to this supposed simplicity that so many have rejected the idea of the mammal being descended from a reptilian ancestor. In the present paper, while I do not intend to discuss the question of the origin of mammals, I wish to show that most of the cranial bones which are supposed to be characteristic of the reptilian skull and absent in the mammal can really be found in one or other of the representatives of the mammalia. As there is to my mind no doubt that mammals are descended from some Therapsidan reptile, most probably a small Cynodont, I shall merely speak of the bones which are known to occur in the Therapsida, and which are not generally recognised in the mammalian skull.

Septomaxillary.

The septomaxillary bone was first discovered by Kitchen Parker in the skull of the lizard and snake, where it is of very large size. In 1900 it was found by Howes and Swinnerton in the skull of *Sphenodon*, and since then I have found it to be probably invariably present in Therocephalians and probably also in all Cynodonts though always absent in the allied Anomodonts. In the lizards and snakes the bone is specialised to serve as a roof and protection to the enormous organ of Jacobson, but in *Sphenodon* we find it in

what is probably its primitive condition as a nasal floor bone. In Therocephalians and Cynodonts the relations of the bone have not been satisfactorily made out, but so far as is known it forms, as in *Sphenodon*, the floor of the anterior part of the nasal cavity and probably also protects the organ of Jacobson.

In mammals the organ of Jacobson is usually relatively small and well enough protected by its cartilage at the base of the septum. The nasal floor is also well protected by the secondary palate. There would consequently seem to be no use for a septomaxillary, and as might be expected it is almost invariably absent. About ten years ago, however, when working at the mammalian organ I came across a hitherto undiscovered bone in the floor of the nose of the Armadillo, *Dasypus villosus*. Though a description of the bone was published at the time, I was unable to come to any conclusion as to its homologies, and it was only when recently working at the organ of Jacobson in *Sphenodon* that I recognised that the septomaxillary of that reptile is essentially similar in its relations to the nasal floor bone of the armadillo. I therefore consider that the small bone in the nose of *Dasypus* is a true septomaxillary which has for some reason been retained from the reptilian ancestor. In *Dasypus villosus* there is a pair of crescentic bones, but in *Dasypus minutus* the bones are anchylosed together.

Prevomer.

Some years ago I endeavoured to show that the paired bones in the front of the palate of the lizard which are usually called "vomers," are not homologous with the mammalian vomer. The vomer of the mammal is a median bone which forms as a splint on the basicranial axis. It may extend from the front of the axis to the basioccipital as in many Cetaceans, or it may be quite rudimentary, as in many rodents. In *Echidna* it is situated far back and does not appear in the anterior nasal region. In its relations and development it agrees exactly with the reptilian bone called "parasphenoid," as was pointed out first by Bland Sutton. The so-called "vomers" of the reptile are paired bones which have nothing to do with the basicranial axis, but develop as splints on the paraseptal cartilages, and principally serve as a protection to the organs of Jacobson. In *Ornithorhynchus* the paraseptal cartilages are protected by a pair of bones exactly as in lizards. These become anchylosed to form the "dumb-bell shaped bone" of the adult, but there can be little doubt that they are homologous with the so-called "vomers" of reptiles. As a new name was necessary for them I proposed to call them "prevomers."

In most mammals they are absent, their place being taken by the palatine processes of the premaxilla. In only one mammal besides *Ornithorhynchus* do I know of them occurring as distinct elements in the adult, viz., the bat *Miniopterus*. According to Kitchen Parker many Edentata and Insectivora have in fœtal life a pair of "anterior vomers," as he called them, supporting the paraseptals, but these early became anchylosed to the premaxillaries to form part of their palatine processes, though there can be little doubt that they are homologous with the prevomers of *Ornithorhynchus*. Prof. Cleland informs me that Goodsir was acquainted with a small bone occasionally present behind the premaxillary and in front of the vomer, and that in conversation he spoke of it as "John Arthur's bone." Most probably this was a prevomer which had appeared as an abnormality. *Gomphognathus* has a well-developed typical vomer and a pair of small prevomers.

Prefrontal, Postfrontal, and Postorbital.

These three membrane bones which are all present in many reptilian skulls are not generally recognised as occurring in the mammalian skull, and in the very large majority of cases there is no trace of any of them. In Anomodonts and Therocephalians all three are probably always present, but one is usually very small. The bone which forms the upper part of the postorbital arch and passes back by the side of the parietal was formerly regarded as the postfrontal, but the presence of a small bone in front of it seems to show that it ought to be regarded as the postorbital, the small bone being the postfrontal. In the Cynodonts, though prefrontals and postorbitals are well developed, no postfrontals have hitherto been recognised, but as only very few good skulls have been examined it is probable that, as in the Anomodonts, all three bones will yet be recognised.

In *Tritylodon* there seems to be a distinct prefrontal and a bone behind the orbit which may be postfrontal or postorbital. Unfortunately the only known specimen is very imperfect, and there has been much discussion as to whether it is a mammal or a reptile, so that any evidence from *Tritylodon* does not at present carry very much weight. I have in a previous paper argued in favour of its being a mammal, and should this prove to be confirmed we shall probably have to admit the prefrontal at least as an element of the mammalian skull.

In *Ornithorhynchus* and *Echidna* there are at least two bones in the brain case which are not usually present in the higher forms.

These are named by van Bemmelen the "postfrontale (orbito-sphenoidei)" and the "parietale-laterale." As both are apparently membrane bones it is likely that the anterior is the reptilian post-frontal and the posterior the postorbital. At the inner and anterior part of the orbit there is a bony plate which may be the prefrontal. It was believed to be so by Seeley, who apparently discovered it as a distinct element. Van Bemmelen does not apparently believe it to be distinct from the frontal, but in two of his illustrations he figures it as distinct. Until further work has been done to the structure of the skull in the young Monotremes the question of whether there is a distinct prefrontal must remain as not definitely settled.

Quadrate.

I have elsewhere given reasons for believing that the mammalian quadrate became lost in the glenoid cavity, at least as a bone. In most mammals there is a distinct interarticular cartilage which may represent it, but in only one known mammal is there a bone. This is in *Pedetes*, the Cape-jumping hare. In it there lies in the front of the glenoid cavity a small flattened oval bone measuring 2 mm. × 1 mm. It is invariably present, but it is likely to be lost if the skull has been macerated. I regret that I have had no opportunity of examining the condition of the parts in the young animal, but hope to have ere long. It is just possible that the bone may prove to be something else than the quadrate, but it is difficult to see what else it can be. It may turn out to be a sesamoid bone in connection with the external pterygoid muscle, but as it is in the same position as the quadrate in the Cynodont reptiles the probability seems to be that it will prove to be a true quadrate bone.

There are evidences of one or two other bones in the mammal of interest. The ossicle of the caruncle in the young Monotremes is probably the internasal process of the premaxillary. I believe there is evidence of a distinct angular in the lower jaw of *Ornithorhynchus*, but this and some other points require further investigation.